ECOPHYSIOLOGICAL ASPECTS OF *QUERCUS PETRAEA* IN FOREST ECOSYSTEMS FROM TROTUS VALLEY (BACAU COUNTY) UNDER CHEMICAL POLLUTION AND DEFOLIATING INSECTS ACTION

ASPECTE FIZIOLOGICE ASUPRA SPECIEI *QUERCUS PETRAEA* SUB ACŢIUNEA POLUĂRII CHIMICE ŞI A DEFOLIATORILOR DIN ECOSISTEME FORESTIERE DE PE VALEA TROTUŞULUI

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Abstract. *The aim of this paper is to evaluate the ecophysiological responses of the Quercus petraea after twenty years of pesticides actions and air chemical pollution. Analyzed forests are situated in neighbourhood of Petrochemical Plant of Borzesti, Bacau County that produced oil petroleum products, pesticides (based on chlorine) and rubber. Response to stress induced by chemical pollution was evaluated based on analysis of physiological leaves of Q. petraea, related to entomological studies on defoliator populations that affected oaks forests in this part of Romania. Physiological researches the plant responses investigated the content of chlorophylls and carotenoids and the sugars metabolism. Entomological studies have assessed the level of Apethymus cereus infestation in oaks stand affected by this pest. Starting from a literature review, we discuss the possible roles of various abiotic (air pollution, climatic extremes, site conditions) and biotic factors (insect defoliation) that have been related to oak decline observed in this part of East Europe.*

Key words: chemical pollution, photoassimilatory pigments, *Apethymus cereus*

Rezumat. *Scopul acestui studiu constă în evaluarea răspunsului ecofiziologic al speciei Quercus petraea din păduri de cvercinee după douăzeci de ani de poluare chimică a aerului şi a solului. Pădurile studiate se află în vecinătatea Combinatului Petrochimic Borzeşti, jud Bacău, care a constituit mulţi ani o sursă de poluare prin producerea de produşi petrolieri, pesticide (oraganoclorurate) şi cauciuc sintetic. Răspunsul la stresul indus de poluarea chimică s-a evaluat pe baza analizelor fiziologice din frunzele de Q. petraea, corelate cu studiile entomologice asupra populaţiilor de defoliatori ce au afectat pădurile de cvercinee din această zonă a României. Studiile fiziologice au constat din analiza pigmenţilor asimilatori(clorofile şi carotenoizi) şi a metabolismului glucidic (mono-, di- şi poliglucide) din frunzele speciei de Q. petraea. Studiile entomologice au evaluat nivelul infestărilor cu Apethymus cereus din pădurile de cvercinee afectate de acest dăunător. Pornind de la o analiză a literaturii, vom discuta despre rolurile posibile ale factorilor abiotici (poluarea aerului, condiţiile climatice extreme, biotopul), precum şi factorii biotici (insectele defoliatoare) care au fost legate de declinul gorunului observate în această parte a Europei de Est.*

Cuvinte cheie:poluarea chimică, pigmenţii fotoasimilatori, metabolismul glucidic, *Apethymus cereus*

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INTRODUCTION

The combined effects of climate change and air pollution are especially affected differently by synergistic or antagonistic action of polluting factors. Authors, who studied the pure stands of oak drying problems in this area, accused some determining factors, including a long drought between 1973-1985 (Ciornei et al., 2001; Popa, 2007). These conditions have encouraged the breeding of *Apethymus cereus* (Kluger, 1918), in sessile oak stands at Heltiu station. In 1994, that pest was first recorded in Romania as invasive species it in Heltiu forest (Căiuţi Forest District, Bacău County), where he produced a massive defoliation area of 150 ha. Maximum level was reached in years 1999 and 2000. Combating major defoliator insects that produced gradations in this forest during 1980-1992 (tortricide, geometride, *Lymantria dispar*) was performed using pesticides products of organochlorine (DDT, found in soil undecomposed after 10 years of application), and organophosphorus and some pyrethroids, nonselective, which contributed to the accumulation of pollutants and disturbances occurred in populations of natural enemies (Hance, Cambier, 2003). After 2000, no pesticide treatments were made in Heltiu and Păltinata forests.

MATERIAL AND METHOD

The studies were made in three stations (forests) located at different distances from Petrochemical Plant Borzeşti, Bacau County. Forests analyzed: Cornatel, Heltiu and Păltinata have 90% of *Quercus petraea* (sessile oak). In the forests studied (organized in landscape units= ua's), the sampling was carried out from several points depending of the distance to the Combined. Păltinoasa Forest is located at a distance of between 5 to 5.5 km Petrochemical and an altitude of 310-450 m. Heltiu Forest is situated at a distance of between 6-12 km from the Petrochemical Plant, at an altitude between 240-410 m. Corneţel Forest - control untreated with pesticides - is at 23 km from Borzeşti Petrochemical Plant and lies at an average altitude of 270 m. The physiological analyses consisted of determining assimilatory pigments: chlorophylls and carotenoids (Meyer-Bertenrath method modified by Ştirban in 1985) and carbohydrate indicators: mono-, di-and polysaccharides (Bertrand-Borell, 1953; Hager et al., 1966). The results were expressed as mg/g of fresh weight (mg/g fr.-assimilatory pigments) and respectively, as g of glucose's per cent (g %) from dry leaf matter (carbohydrate indicators). Based on the results the statistical analyses were performed.

Setting defoliator insect infestation was made on permanent sample trees corresponding to the entomological methods.

RESULTS AND DISCUSSIONS

Studied area

The studied area (different oak stands) from the North-Eastern part of Romania belongs to the geographic unit of Moldavia Subcarpathians, along Trotus Valley, between the Onesti and Adjud towns situated in Bacau County. The localization of the Petrochemical Plant of Borzeşti in this area permitted the influence of the polluted air for many years, because of industrial emissions like

halogenated and nitric elements, phenols, hydrochloric acid, ammonia, aldehydes, solvents, sulphurous acid, and metallic carbide (Ciornei et al., 2003).

Ecopedological and climatic factors

Pedogenetic processes specific for this studied zone determined by the climatic phenomenon and the soil is the illuvial clay. The type is preluvosoil and luvosoil. Ecological conditions represented by the rocky forest soil with the pH from moderate to a strong acid (4.5-4.6), oligobasic trophicity, permeable and dry loosing water along the slopes located on sand and gravel deposits nonhorizontals.

The directions of the winds downstream of the valley transported the polluted emissions damaged the pure oak stands, especially from Heltiu forest (Popa, 2007). Beginning with year of 1997 mean of annual precipitations registered a progressive decreasing from 850 mm/year to 400 mm/year in 2000 year. During that period the temperature increased from 8°C (1996 and 1997) until 11°C (2000 year). In 2008, mean of April precipitations registered a value of 100 mm and also, in May and June, a value of 30 mm, which was much lower (fig. 1). In 2007 and 2008, temperatures have maintained the same increasing trend, while precipitation has decreased dramatically in 2007, in June (fig. 1)

Biotic factor

Since 1998 and continuing until 2000, the mean of annual temperature increased from 9.5 °C to 10.5 ° C, which is above than mean of multi-annual value of 9.2 ° C (fig. 2). In parallel, we found an increase in population densities of *Apethymus cereus*, defoliator of sessile oak forests in this area. Thus, in spring 2000, the average density of eggs of this pest species recorded the value of 95.66%. In 2008, after treatment with chitin synthesis inhibitors (Rimmon and Dimilin) egg density of *Apethymus cereus* reached to 0.1% in Heltiu forest (fig. 2).

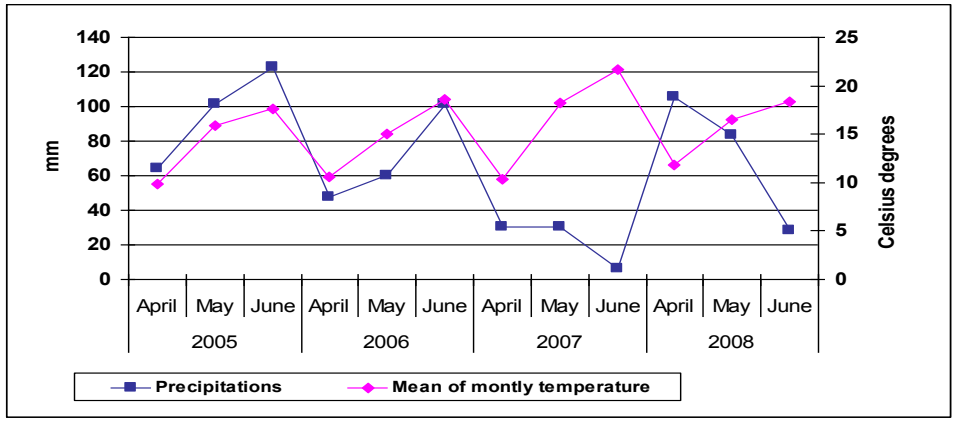

Fig. 1– Means of temperature and monthly precipitations

Regarding pest larval density *Apethymus cereus*, it was an increase from 0.3% in 2001 to 30.9% in 2002. In 2008, the average was 0 %. In recent years

there have no correlations between larval density and mean of annual temperature (Ciornei et al., 2007).

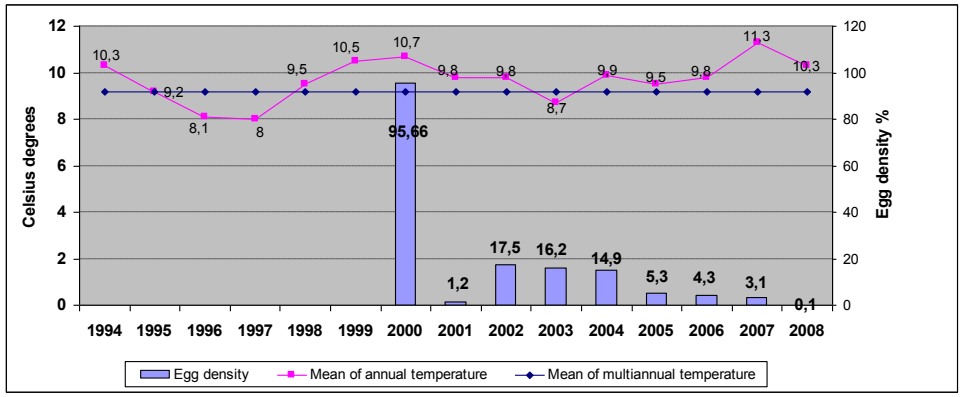

Fig. 2 - Variation of egg density of *Apethymus cereus* from Heltiu forest in correlation with mean of annual temperature between 2000-2008

Aspects of *Quercus petraea* physiology

Ecophysiological response of *Q. petraea* to the converged action of factors biotic, abiotic and residual pollution was evaluated by investigating the specific parameters (chlorophylls, carotenoids and carbohydrates). Previous researches in that field were limited concerning the observation of the chlorosis, dryness phenomenon, the decrease of the density foliage, debilitation and decline of the sessile oak from this forest (Murariu et al., 1997; Ivănescu et al., 2003; Popa, 2007).

Present study observed that in May (in 2006 and 2007) the values of assimilatory pigments are lower in leaves species of *Q. petraea* from Heltiu and Păltinata forests, comparatively with untreated control (Cornăţel forest). Especially, chlorophyll a registered lower values in tree leaves at Heltiu and respectively Păltinata in comparison with control (fig.3). In May 2007, chlorophyll b recorded the lowest value (0.142 mg/g fr.w) and chlorophyll a the highest value (1.17 mg/g fr.w.) in leaves of forest trees Păltinata.

This variation led to the unbalanced ratio of 8.26 (being 2.6 times higher than control) between the two chlorophylls (a/b), in leaves of *Q. petraea* at Păltinata station. In August 2008, photosynthetic parameters registered higher values compared with the control, which may show a slower metabolism of this species from the stations situated under the chemical action of pollutants. During studied period, carotenoids registered comparable values with those of control (fig.3).

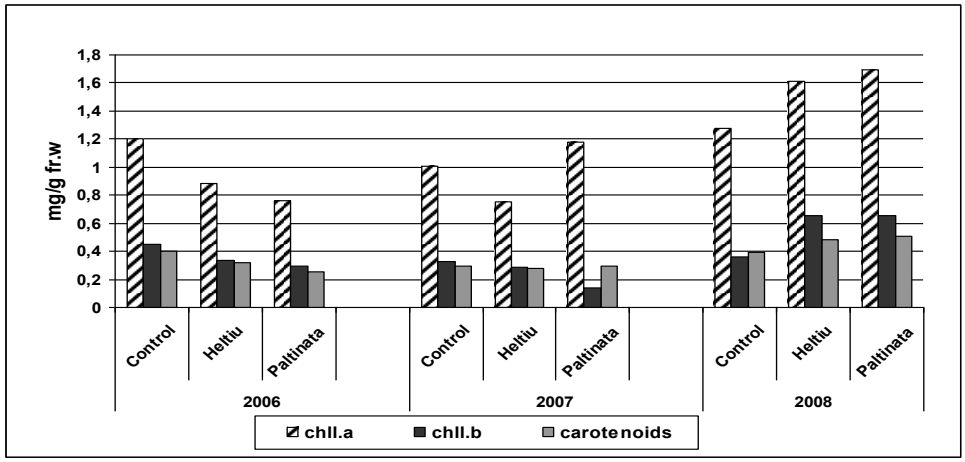

Fig. 3 - Variation of the photoassimilatory pigments in leaves of *Q. petraea* at studied forest ecosystems

Sugar metabolism was studied through analysis of the monosaccharide, disaccharide and polysaccharides In 2006 and 2008, analyzed carbohydrates indicators registered the lower values in leaves of *Q. petraea* at Păltinata station (fig.4).

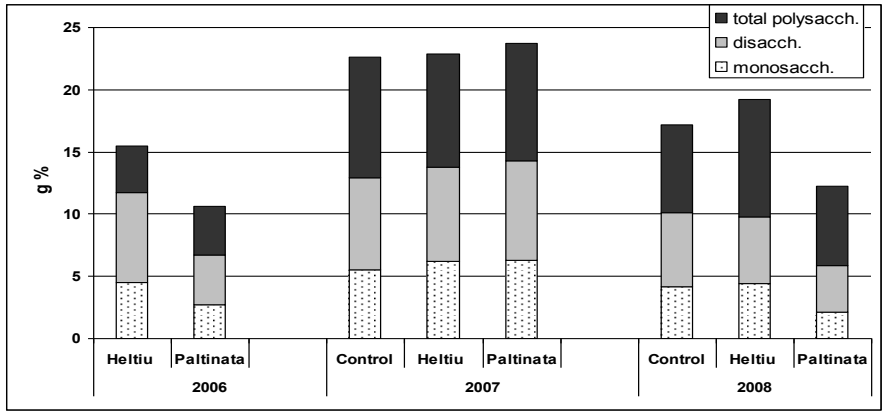

Fig. 4 - Variation of the sugars parameters in leaves of *Q. petraea* at studied forest ecosystems

In 2007, it could be possible that some stationary factors (low rainfall, high temperatures etc.) led to an acceleration of carbohydrate biosynthesis and thus to the obtaining the quite close values of the analyzed parameters from all studied stations (fig. 4). It was found that the ecophysiological response of species *Q petraea* is still influenced by residual pollution in the soil and also, by the climatic factors. Chlorophylls pigment analysis showed the lower values in the forests Heltiu and Păltinata (affected by pollution) and a decreased photosynthetic efficiency (changing ratio chlorophylls a/b) in Păltinata forest.

CONCLUSIONS

1. Investigation of physiological processes in *Q. petraea* showed that the biosynthesis of chlorophylls and carbohydrate metabolism in the leaves of this species showed changes in analyzed forest ecosystems.

2. Once with reducing distance from the pollution source was found the decreasing of the values of physiological parameters analyzed. Thus, the lower carbohydrate values were recorded in forest ecosystem of Păltinata, the closest with Petrochemical Plant Borzeşti.

3. Sinergic action of some factors such as, climatic (drought), biotic(pest attack) with soil deposits (pollutants) influenced over a long period the ecophysiological parameters in Q. *petraea* at oak forest ecosystems from Trotuş Valley.

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